

[COMMUNICATION]

Preference for Striped Backgrounds by Striped Fishes

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ABSTRACT—Six available species of freshwater fishes, two cross-striped, two lengthwise-striped and two non-striped ones, were exposed to vertically and horizontally striped backgrounds. The two cross-striped fishes preferred to rest at vertically striped sites over horizontally striped ones. One of the two lengthwise-striped fishes tended to rest at horizontally striped sites. These results imply that many striped fishes prefer resting at sites with stripes similar to their own. The behavior of one non-striped fish suggests that there may be a factor other than a fish's own stripes that causes preference of vertically striped sites.

INTRODUCTION

Cryptic animals must merge with their backgrounds [1, 2]. It is known that some cryptic animals choose resting places appropriate to their body colorations [3–5]. Kohda and Watanabe [6] showed that the freshwater serranid fish oyani-rami, *Coreoperca kawamebari*, which has cross stripes on its body, chooses to rest at vertically rather than horizontally striped sites.

Do cross-striped fishes other than the oyani-rami have the same preference? Do lengthwise-striped fishes prefer horizontally striped sites? Do non-striped fishes have any preference between vertically and horizontally striped sites? In the present study, we tested the preferences of six available species of freshwater fishes including the oyani-rami for striped sites.

MATERIALS AND METHOD

Ten individuals from each of six species were

used; two cross-striped fishes, *C. kawamebari* (7.8–8.8 cm in total length) and *Macropodus chinensis* (3.2–4.0 cm), two non-striped, *Carassius auratus* (6.3–8.0 cm) and *Acheilognathus limbata* (5.0–7.4 cm), and two lengthwise-striped, *Barbus itteya* (3.0–3.4 cm) and *Melanochromis auratus* (3.5–5.1 cm). The four former species were collected in Okayama Prefecture, Japan, while the latter two were obtained from a tropical-fish dealer.

As all the specimens were small, we used an experimental apparatus different from that used in our previous study [6]. Instead, we utilized a gray plastic tank 150×100×50 cm high (20 cm deep), which had two vertically striped and two horizontally striped shelters (Fig. 1B). Shelters were transparent plastic boxes (15×15×15 cm), which had three striped side walls and one open side, and were put on squares (25×20 cm) bordered by a light green line (Fig. 1A). The stripes were 2 mm black bands with 2 mm transparent intervals.

A fish was placed in the center of the tank, and the time the fish spent in each square was recorded for 30 min. The fish was left in the tank and the next day its position was recorded again for 30 min. Five of the ten fishes of each species were tested under one arrangement of shelters (Fig. 1B), and the other five were tested under the reverse arrangement. Preference for stripes by each species was tested by the two-tailed matched pairs signed test [7].

RESULTS AND DISCUSSION

In the first-day test, the two cross-striped species, *C. kawamebari* and *M. chinensis*, preferred

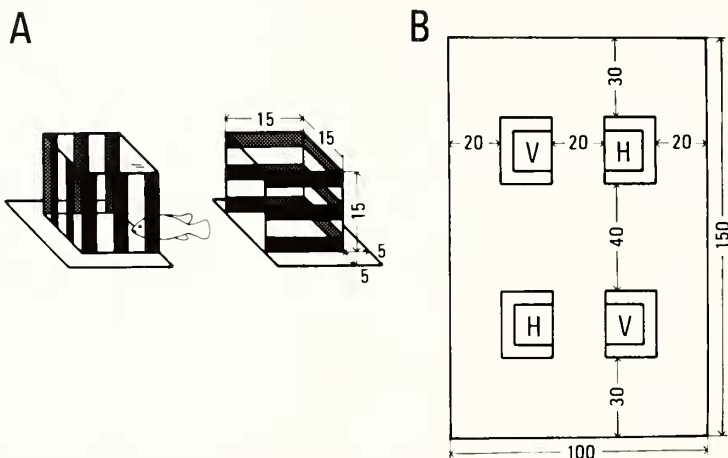
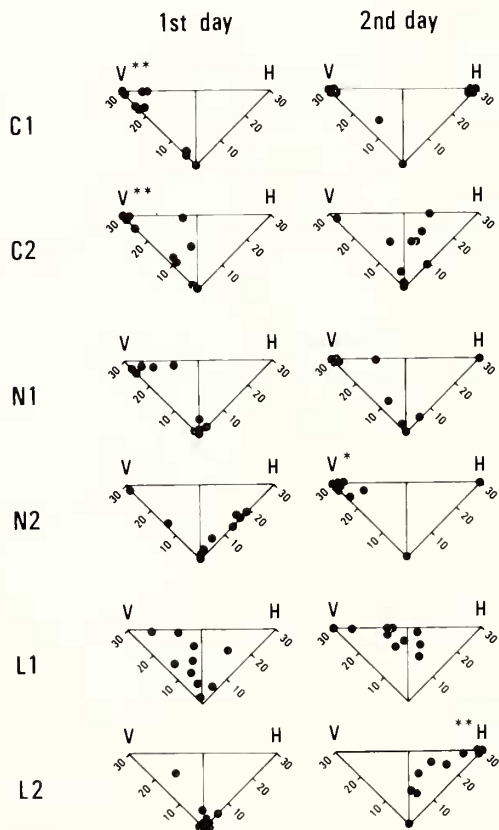


FIG. 1. Schematic representation of striped shelters and experimental apparatus.

(A) Striped shelters (15×15×15 cm) having three vertically or horizontally striped side walls and one open side were put on squares (25×20 cm) bordered by a light green line. The stripes were 2 mm black bands with 2 mm transparent intervals.

(B) One arrangement of striped shelters in the experimental tank (150×100×50 cm). V: vertically striped shelters, H: horizontally striped shelters. Half of the specimens were tested under this arrangement of shelters and the other half were tested under the reverse arrangement.



vertically striped zones to horizontally striped ones (both $r/n=0/9$, $P<0.01$) (Fig. 2). The two length-wise-striped and the two non-striped species showed no preference ($r/n=2/10$, $1/8$, $2/10$, $2/6$, all $P>0.05$).

In the second-day test, one of the two length-wise-striped fishes, *M. auratus*, preferred horizontally striped sites ($r/n=0/9$, $P<0.01$) (Fig. 2). One of the two non-striped fishes, *A. limbata*, showed a slight preference for vertically striped zones ($r/n=1/9$, $P<0.05$). The other four species showed no preference ($r/n=4/9$, $3/8$, $2/9$, $3/10$, all $P>0.05$).

On the first day, the specimens were unfamiliar

FIG. 2. The time that the fishes spent in the striped sites during the 30 min observation time. One dot represents the data of one specimen. The foot of the perpendicular from a dot on the V-axis is the time (min) spent in the vertically striped sites and the foot on the H-axis is the time spent in the horizontally striped sites. 1st day: the results of the tests immediately after placing the specimens into the experimental tank, 2nd day: the results after one-day of adaptation. C1: *Coreoperca kawamebari*, C2: *Macropodus chinensis*, N1: *Carassius auratus*, N2: *Acheilognathus limbata*, L1: *Barbus titteya*, L2: *Melanochromis auratus*. *: $P<0.05$, **: $P<0.01$.

with the experimental tank, and might have been frightened and thereby motivated to seek refuge. On the second day, they probably knew the geography in the tank, and their motivation to seek refuge was probably smaller than on the first day. No fish preferred the same striped zone on both days, but we can infer that the species which chose either zone on either day have a preference for that stripe.

Kohda and Watanabe [6] showed that the oyanirami, a cross-striped fish, prefers vertically striped sites and this was reconfirmed in the present study. The other cross-striped fish, *M. chinensis*, showed the same preference. A lengthwise-striped fish *M. auratus*, preferred horizontally striped sites. These three fishes tended to rest at shelters with stripes similar to their own. One lengthwise-striped fish, *B. titteya*, showed no preference. None of the four striped fishes showed a preference for stripes unlike their own. These results imply that many striped fishes prefer resting at sites similar to their own body stripes, thereby camouflaging themselves. Further studies with more striped species are needed to prove this hypothesis.

One non-striped species, *C. auratus*, showed no preference, and this result conforms to our hypothesis. However, the other non-striped one, *A. limbata*, showed a slight preference for vertical stripes over horizontal stripes on the second day.

This observation means that there may be a factor other than a fish's own stripes causing a preference for vertically striped sites. In order to determine what this factor is, we need to observe the behavior of many non-striped fishes that show a preference for vertical stripes and to find which character of these fishes correlates with their preference for vertical stripes.

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